The Chemical Age

A Weekly Journal Devoted to Industrial and Engineering Chemistry

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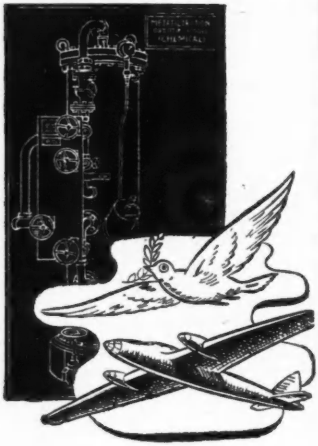

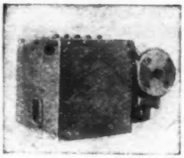

The Chemical Age

A Weekly Journal Devoted to Industrial and Engineering Chemistry

BOUVERIE HOUSE, 154 FLEET STREET, LONDON, E.C.4

Telegrams: ALLANGAS FLEET LONDON — Telephone: CENTRAL 3212 (10 lines)

GLASGOW: 116 Hope Street (Central 3970) — BIRMINGHAM: Daimler House, Paradise Street (Midland 0784-5)

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The Electron Microscope

HUMAN nature is such that the surest way of persuading people to do a thing is to tell them that they cannot do it. Thus, as soon as scientific discovery found that there were limits to the vision that could be obtained by the optical microscope, man began to search for means by which he could see that which he had not been able to see before. This was not mere curiosity, however, because sub-microscopic objects are of the greatest importance. It could be deduced, for example, that there were probably bodies so small as to pass through any filter, and so minute as to be invisible in the highest-powered microscopes, that were responsible for many diseases. These were christened the viruses. Their existence was postulated or suspected, but there was no proof. Until one knows that a thing has material existence one cannot proceed with certainty to kill it.

Chemists have postulated the existence of atoms. They have decided on theoretical grounds that these atoms must combine to form molecules. Unfortunately, no one had seen an atom or molecule and thus it is still necessary to speak of the atomic "theory." The physicist has deduced, by ingenious mathematical treatment of speculations based on experimental facts, the probable constitution of the atom and has given us a picture of electrons, protons, neutrons, forming miniature solar systems of great interest and complexity. Unfortunately, again, no one has seen an atom and we do not, therefore, know with complete certainty whether or not we have built for ourselves a golden image and are bowing down before idols in which there is no truth. Many of those engaged in scientific research must have spent months compiling observations on which elaborate speculations could be based, but which somehow did not fit into any general picture, until one day there came an opportunity of seeing the thing about which all the speculation was made, and then the whole jig-saw pattern fitted beautifully. Certainly, we ourselves have had this experience.

It is therefore of the highest importance that every possible attempt should be made to pierce beyond the dimensions to which we are limited in the optical microscope. We believe that the limit of vision is about 2000 diameters. It is possible, of course, to obtain higher magnifications than this. It is understood, however, that the higher magnifications increase the size without increasing the clarity of detail. This is, of

On Other Pages

course, the direct consequence of the wavelength of light and of the fine structure of the human retina. If we can use radiation of shorter wavelength we can see more minute objects.

The latest development, already well known in the scientific world, is the electron microscope. This instrument is so important industrially, medically, and from every scientific angle pure and applied, that it is highly desirable that its potentialities should be more fully recognised. Those who were privileged to hear Dr. E. H. Rayner, late of the National Physical Laboratory and now of the General Electric Company, Ltd., talk on this instrument to the Institute of Physics, must have left the meeting with a lively appreciation of the wide range of possibilities that have been opened by the development of this instrument. It is an instrument which has not been successfully developed in this country, unfortunately, and we appear to have left it to the Germans and the Americans. It is fortunate that the Americans have taken a hand in it because we are now able to obtain some of these instruments from America under the Lease-Lend arrangement. The Radio Corporation of America (R.C.A.) have been very greatly responsible for what has been achieved. The original idea appears to have been developed in a Berlin technical college between 1930 and 1937 and later by the same workers in the Siemens Laboratories. Independent work was, however, going on by Dr. Marton at Liége and by Dr. Hillier in Toronto. R.C.A. engaged both of these men, and gave them a first-class research team under the direction of Dr. Zworykin, and within less than two years an electron microscope was available for sale as a research unit. How many are in this country is not clear, since different authorities have stated 5, 6 and 7 as the numbers that are at work here at the present moment.

The electron microscope works on the principle that the waves associated with a beam of electrons are very much shorter than those of light and that their wavelength can, moreover, be varied by varying the exciting voltage. As the voltage becomes greater the wavelength appears to become less, so that, on the original theory formulated by de Broglie, an electron accelerated with 60,000 volts would have an equivalent wavelength of 0.5×10^{-10} mm. This is the usual voltage applied, but some instruments for research purposes can go up to 300,000 volts. In place of lenses for focussing the rays the instrument uses magnetic fields, and in this way an enlarged image of a transparent object is obtained on a fluorescent screen or a photographic plate. Means are adopted whereby this image can be examined directly by eye.

The constructional details of this apparatus do not concern us here. We are more concerned with its application. Besides showing bacteria and viruses too small to be seen in an optical microscope, and the beautiful and certain proof of the diffraction-grating mechanism causing the iridescent coloration of butterflies' and beetles' wings, Dr. Rayner also demonstrated how it is now possible to investigate the surface structure of metals and chemical products. In order to do this the surface is covered with a very thin film of gelatine, of little more than molecular thickness. When this is peeled off and examined, the surface of the original material is shown in marvellous detail. A particularly interesting specimen was that of magnesium in which the crystal shapes were clearly visible, standing out with the clarity of a view of New York skyscrapers from the Statue of Liberty. When this surface was oxidised it was seen that the effect was just as if all the corners had been made to flow like a number of minute blocks of ice that had just started to melt. Is this, we are disposed to ask, a specific appearance of magnesium oxide or is it because in the combination of magnesium and oxygen such intense local heat was developed in a layer only a few atoms thick as to cause the surface to melt to that depth?

The wonders of the electron microscope have not yet been fully explored, and improvements are still necessary. One of the first difficulties is that the instrument must work in a vacuum, because otherwise the waves would be absorbed. This makes it difficult to examine living objects. Another difficulty is that at present the substances examined must be exceedingly thin. With the present technique it appears possible to see the atoms of elements of an atomic number greater than 25; further progress must wait upon the discovery of means of correcting spherical aberration.

NOTES AND COMMENTS

Margarine

IT is just 75 years since margarine was first produced. What a pity it is that the British public cannot be given a double butter ration to enable it to celebrate the anniversary! All joking apart, however, we must admit that during this war margarine has proved itself a most successful substitute. As Mr. A. J. Anderson said, in his lecture on margarine manufacture, to the joint meeting of the Institution of Chemical Engineers and the Society of Chemical Industry, it has proved a reliable friend and has been of greater service than many of those commodities like fruit, fish, milk, and eggs, which before the war were eulogised by dietary experts and proclaimed in glaring advertisements. On nutritional grounds there is nothing to choose between it and butter. Improvements which have been added to the original process devised by Mège Mouriés have brought the manufacturer to the stage when he can turn out a product that is inferior to butter only in flavour and texture. To match the aroma of butter is a tricky business, and although chemists have identified acetylmethylcarbinol and diacetyl as being important constituents of butter aroma, it is still found best to rely on bacteria to produce the desired flavour. In the matter of texture, an infinite range of margarine varieties is possible, but here again the manufacturers seem to have some difficulty in producing a product as attractive to the palate as is butter. It should not be forgotten, however, that the special "tropical" margarine issued to the Services remains more appetising than would butter under similar conditions of extreme heat.

Collegiate Exchange

A WELCOME note of genuine inter-Allied co-operation in the realm of science is struck by Professor Southwell's letter published in *The Times* on Friday last week. An arrangement has been arrived at, between the Massachusetts Institute of Technology and the Imperial College of Science and Technology, whereby a regular interchange, after the war, of staff and post-graduate students will be maintained between the two institutions. The Rector of Imperial College likens the arrangements to the "pairing" of Oxford and Cambridge colleges, by which educational and social privileges are extended, by each college so allied, to members of its "opposite number"; and one of the main merits of the scheme, in our view, is its essential informality, which is consonant with both the British and the American spirit. Professor Southwell, modestly but justly, goes on to expand on the honour done to the comparatively junior South Kensington College by its elder brother in Boston. It is a change, and a salutary change, for seniority in point of foundation to be acknowledged to an American institution. Our friends from the States must sometimes be a little wearied by our tacit assumption of the virtue that adheres to mere antiquity, and it is a good thing for both of us that the tables should for once be turned. Antiquity apart, the "Boston Tech" is an institution that has won the deserved admiration of scientists and technologists throughout the world, and to have arranged this friendly agreement with it is a feather in the cap of Professor Southwell, and a great score for the college over which he presides. We feel sure that the members of Imperial College will see to it that their American "opposite number" does not lose by the exchange.

Research in Sweden

THE need for intensive research arising out of war-time necessities and shortages is by no means confined to the belligerent states; neutrals also have their problems in a "world war," and have exercised great ingenuity in providing solutions for themselves. Sweden, for example, has been making great efforts to provide home-produced substitutes for certain imports, and at the annual meeting of the Swedish Academy for Engineering Research, the past president, Mr. Axel Enström, gave a survey of some of the achievements of Swedish research workers during the past year. For example, two-thirds of the national requirements of phosphoric fertilisers have been met by utilising the apatite contained in certain iron ores, and three-quarters of the country's needs of

nitrogenous fertilisers have been met by the construction of new factories. Shale oil has proved an excellent basic product for further treatment, and it can now be converted into lubricating and transformer oils, as well as shale benzene. The problem of petrol or benzene storage for lengthy periods has been solved by the addition of stabilising substances in small quantities, and corrosion from petrol/alcohol mixtures in steel containers has been prevented by coating the containers with a lacquer of synthetic resin.

Utilising Wood Products

GOOD lubricating oils are now produced in Sweden from tree-stump tar, which also supplies softening preparations for road-surface pitch and substitutes for tallow and fat and for certain pigments. Birch-tar oil replaces animal fats for the softening and preservation of leather. Research in wood-pulp and its by-products has made great strides. The production of viscose or rayon pulp is no longer dependent upon spruce wood, and by means of mechanical breaking in a vibration mill a product is obtained with uniform length of molecules and with correspondingly improved properties. By mixing synthetic resins in fibres and producing a chemical combination between the cellulose fibre and formalin, it has been possible greatly to counteract the creasing and shrinkage of cloth. Great advances have been made in both the yield and the quality of cellulose products. Synthetic resins are now made in Sweden by several firms, as well as lacquers for use in the electrical industry. and for paint manufacture. Products possessing rubberlike qualities are already being turned out, and preparations for the manufacture of synthetic rubber on a small commercial scale are under way.

Wholesale Prices in 1943

THE general impression conveyed by the Board of Trade review of wholesale prices in 1943, at any rate so far as industrial materials and manufactures are concerned, is one of increasing stability. Taking, as usual, 100 as the average price figure in 1930, the Board of Trade index number at the end of December last was 165.7 in the industrial group, an increase of only 3.9 over the figure for December, 1942. This is the smallest annual rise so far recorded since the war, the previous increases having been 22.9 in 1939-40, 17.4 in 1940-41, and 4.3 in 1941-42. The percentage rise of 1943 over 1942 gives an even greater impression of stability, being identical (2.3 per cent.) with that for 1942 over 1941. Contributory to this factor have been the price of non-ferrous metals, which has remained stationary for over twelve months, and that of iron and steel, which has shown an increase of only 0.2 per cent. On the other hand, the "chemicals and oils" group has evinced a greater change than any, having increased 6 per cent. during 1943. This was due mainly to rises of 18 per cent. and 35 per cent. in the prices of ground-nut and palm-kernel oil respectively (with a consequent rise of 20½ per cent. in standard household soap), while the 13 per cent. rise in the price of varnish and the 8½ per cent. increase in the cost of "Pool" burning oil had a considerable effect also. Rubber (up 31 per cent.) and mechanical wood pulp (up 15 per cent.) accounted for a large share of the 4.1 per cent. increase recorded for the "miscellaneous" group. The stability of the metal-prices index will be rudely shattered this year, however, by the notable increase in the price of tin which has already been recorded.

CANADA SHORT OF POTASH FERTILISERS

Potash available for fertiliser purposes in Canada in 1944 will not exceed 35,000 tons, representing about 80 per cent. of the quantity used in 1943, though this year's demand for potash fertilisers is expected to increase. This forecast was made by Mr. G. S. Peart, fertiliser administrator of the Agricultural Supplies Board, recently. He said that rationing of potash is already in effect. Manufacturers of fertilisers have been allocated about 73 per cent. of the potash used in 1943 and have been instructed to supply distributors with fertilisers containing not more than 73 per cent. of the potash supplied them in 1943. In turn, the distributors are expected to supply their farmer customers on the same basis. Most mixed fertilisers have been reduced two per cent. in potash content to maintain total tonnage, and these will still contain sufficient potash for satisfactory results under most conditions.

World's Largest Magnesium Plant

Designed by British Technicians

THE plant of Basic Magnesium, Inc., in Southern Nevada, turns out more metal than any other single magnesium plant in the world. It uses all the peat moss Canada can supply, and all the power that Boulder Dam can spare, and its requirements in man-power and electrical equipment are colossal. It is a curious fact, however, that it is to the erstwhile superiority of Germany in magnesium production and technology that the company owes its existence.

Alloys of magnesium were used by the Germans in the last war and were manufactured afterward by I. G. Farbenindustrie under the trade name of Elektron alloys. Major C. J. P. Ball, a British officer, became interested in these alloys during the war, and for years thereafter he worked to form a company to produce them in England. In 1936, he was successful, and Magnesium Elektron, Ltd., was formed, a company which was able to purchase German patent information and had the benefit of German experience in magnesium production. At present the big MEL plant near Manchester accounts for about 80 per cent. of British magnesium production.

Plant History

Basic Magnesium, Inc., was originally the corporate result of a union between Magnesium Elektron, Ltd., which was to furnish the technical knowledge, and Basic Refractories, Inc., Cleveland, Ohio, which was to supply the raw material and direct the enterprise. Defence Plant Corporation financed the deal whereby a magnesite deposit in Gabbs Valley, Nevada, owned by Basic Refractories, would be developed, and a reduction plant erected on a site convenient to Boulder Dam power. The contract was signed on August 13, 1941; the desert site was prepared in September; foundations were being poured in November; and in August, 1942, magnesium ingots were being produced. Plant design was directed by Dr. S. J. Fletcher, chief chemist,, and J. R. Charles, chief engineer, of the British company. Accompanied by some 3000 drawings and specification sheets, these two men left England in May, 1941, on a ship which was torpedoed and sunk in mid-Atlantic. Fletcher and Charles were picked up by other ships in the convoy, but the drawings were lost. On arrival in Cleveland on June 3, they cabled to England for microfilm copies of the entire set, the first of which arrived by special bomber on June 7.

At first, Charles and Fletcher were asked to design a plant to produce about 45 tons of magnesium daily, but no sooner had they completed this design than they were asked for more than treble the output. Naturally, this involved more than multiplying everything by three, and the result was an enormous amount of work handled by these two men under the greatest possible pressure. In three months they did a job that might reasonably have occupied a year in ordinary times. Following the first production of magnesium in August, 1942, however, the output of metal did not come up to expectations. Whatever the cause, the effect was that on October 26, 1942, the Anaconda Copper Mining Co., at the invitation of Government agencies, assumed direction of B.M.I. by buying the controlling interest held by Basic Refractories. The status of Magnesium Elektron, Ltd., was not affected, and Charles and Fletcher remain at the plant in their former capacities.

Transporting the Ore

The mine, some 300 miles north of the reduction plant, is far up on the side of one of the vast Nevada valleys. Here, 31 miles from the railway and 1100 miles by rail from the reduction plant, is a concentration of almost pure magnesite. Ore sent to the mill must meet certain requirements of composition. It must contain not more than 4 per cent. insoluble material, 4.5 per cent. CaO, or 2 per cent. FeO and Al_2O_3. MgO content should be about 40 per cent.

The calcined magnesite is carried to the railway in trucks with semi-trailers. These have specially-designed bodies made in the form of bottom-discharge hoppers, the gates of which are made to fit the unloading bins. As soon as sufficient trucks are available, the long rail haul will be eliminated, and the calcined material will travel directly to the plant by road.

The sequence of operations in the main reduction plant is as follows: (1) calcined magnesite, mixed with coal and peat and suitably prepared, is heated in furnaces (called chlorinators) in an atmosphere of chlorine; (2) the anhydrous $MgCl_2$ formed in the chlorinators is transferred to electrolytic cells, where molten magnesium collects in a pool on the electrolyte's surface; (3) the molten magnesium, dipped out of the cell by hand, is then refined and cast into bars. In addition to these main units, the preparation plant, the chlorinators, the cell houses, and the refining plant, the company also operates a chlorine plant, a flux preparation plant, a caustic soda plant, a brine plant, and a $MgCl_2$ liquor-preparation plant.

On arrival at the reduction works the

* Abridged version of article by Robert H. Ramsey in *Engineering and Mining Journal*, Oct. 1943, p. 61.

concentrates are dumped into hoppers, from which elevators carry the material into one of five 60-ft. silos, each of which holds about 5000 tons. These concentrates must contain less than 1.5 per cent. CaO, 1 per cent. insoluble matter, and 0.5 per cent. each of FeO and Al_2O_3. Not all the concentrate need be calcined magnesite, however. Up to 75 per cent. of the concentrate used can be the carbonate, but ordinarily not so much carbonate is used, and magnesium oxide makes up the greater part of the raw material.

The other primary constituents of the feed to the reduction plant are peat moss from Canada, coal from Utah, and certain salts of unspecified composition which assist in the subsequent reactions. Coal acts as reducing agent and peat makes the mixture porous. For use in the process, the peat is shredded in a hammer mill to minus-8 mesh. The coal and the salts are ground to minus-200 mesh, and all three ingredients are then stored in small concrete silos.

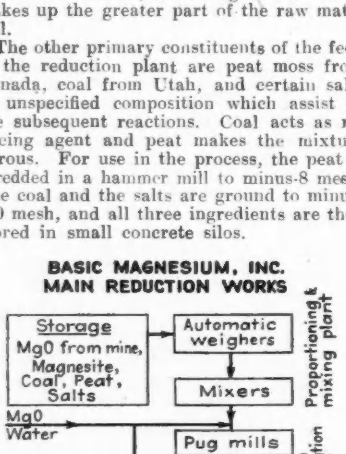


Fig. 1. Flow diagram.

These five materials—magnesia, magnesite, peat, coal, and salts—are removed as needed by belt conveyors to the proportioning plant. Here each is weighed out of its respective bin by a feeder and sent by screw conveyor to one of several rotary mixers. From these mixers the charge is fed continuously to several pug mills, in which concentrated magnesium chloride solution is mixed with the dry mass until a thick dough has been produced. This magnesium chloride solution is obtained by mixing calcined magnesite with HCl derived from the chlorinator exhaust gases. Between this point and the chlorination step, two processes are followed. The purpose of each is to dry the dough in pellet form so that it will make a more suitable feed for the chlorinators.

In one part of the preparation plant, the dough from the pug mills is extruded by a screw conveyor through a rectangular opening, 8 by 10 in., and is cut into 2-in. bricks which pass on a metal conveyor through a drying oven. They are then conveyed on small cars through a tunnel kiln, where sufficient heat is applied to cement the mix but only to char the peat in the mixture. These hard blocks are then broken into 2-in. lumps and are ready for the chlorinators.

In the other part of the plant, the dough from the pug mills is fed to rotating cylinders in which the pasty mass is broken and formed into a collection of balls or pellets averaging about an inch in diameter. These pellets are discharged into driers and then pass into one of four rotary kilns, 100 ft. long. After passing through water-cooled cylinders, the rotary-kiln product is ready for the next step.

The pellets of mixed and dried raw material are transported in trains of small cars, each one a kettle-shaped pot holding about 300 lb. of pellets, to the chlorinator buildings. Each of these many-storied buildings is divided into two main rooms, in one of which are eight chlorinators, while in the other and larger room are 88 electrolytic cells.

Chlorine Plant

With a capacity of about 200 tons of liquid chlorine per day, the B.M.I. chlorine plant is one of the largest ever built. The Hooker cells are housed in two buildings, 450 in each. Salt is obtained by special Government permission from Death Valley and is dissolved in water in turbo-agitators. The solution is brought to the proper concentration in large evaporators and is then pumped through the cells. A current of 750 amp. is applied to the cell circuit; voltage drop is about 3.3 per cell. For the present the hydrogen, the hydroxide, and the residual salt are all going to waste, pending construction of means for their recovery. Eventually, the hydrogen will be collected for sale, as will the sodium hydroxide. The remaining salt solution will be concentrated and re-used. Because chlorine is released in the electrolysis of magnesium chloride, most of the chlorine used in the chlorinators will come directly from the cell house, and eventually the chlorine plant will be required only to make up losses in the circuit. When this balance has been attained, B.M.I. will have available for sale much of its liquid chlorine production.

To get back to the chlorinators, to which the chlorine is pumped in the gaseous state: these are cylindrical furnaces about 12 ft. in outside diameter and 25 ft. high, consisting

of a metallic shell enclosing a refractory lining. In this shell are a bell-and-hopper arrangement at the top for introducing the pellets, an inlet for chlorine gas, six openings through which carbon electrodes project into the interior, a port for the removal of waste residues, an exhaust port where gases escape from the furnace, and a tap hole near the bottom where molten $MgCl_2$ is removed.

Operating Method

Operation appears fairly simple. About 300 lb. of fresh dry mix, prepared as outlined, is dumped into the top of the chlorinator every hour or so, and the accumulated molten $MgCl_2$ is drawn off below, also about once an hour. Inside the chlorinators, the electrodes, arranged in two sets of three each, carry a current which maintains an interior temperature of over 850°C., or sufficient to permit reduction of the MgO contained in the dry mix. Under these conditions magnesia combines with carbon and chlorine to form anhydrous magnesium chloride and carbon monoxide. The molten chloride collects in the lower part of the furnace in a pool. Exhaust gases of the chlorinators carry hydrochloric acid and some magnesium chloride, as well as carbon monoxide. These gases pass through scrubbing towers and various solution tanks in which the HCl and the $MgCl_2$ are dissolved out. The resulting acid solution is then neutralised with calcined magnesite, evaporated to a high concentration, and stored for use in mixing the "dough" which eventually constitutes the chlorinator feed.

Left behind in the chlorinator is a residue composed of silica, alumina, iron oxides, and other impurities. Because these impurities are present in such small amounts, they do not accumulate rapidly, and only after about three weeks of operation is it necessary to shut the chlorinator down to clean out the residues. Electrodes are also changed or renovated at this time.

When it is desired to tap a furnace, a truck-mounted ladle is moved up underneath the tapping point. The clay plug in the tap hole is driven out and a red stream of liquid anhydrous $MgCl_2$ pours out. The fluidity of the chloride is rather surprising; it flows and splashes like water, in contrast to the behaviour of molten metal. When full (each ladle carries about 2 tons) the car bearing the ladle is driven to the banks of electrolytic cells, each one of which has openings in the top fitted with small doors. These doors are opened in turn, a funnel-like apparatus is inserted into the opening, and the molten chloride is poured into the cell through the funnel. A ladle-full suffices to refill several cells, and the ladle, when empty, is immediately returned to a different chlorinator for another load.

The cells, arranged in eight rows of eleven each, are covered receptacles about the size of two bath-tubs placed side by side. The tanks are steel, but the entire lining is of a refractory material. Through the covers of the cells project the electrodes, six steel cathodes and three graphite anodes, and an exhaust pipe through which chlorine leaves the cell. The gas escapes at the anodes and is caught by shields which enclose the anodes to a depth well below the electrolyte surface. Magnesium metal forms at the unshielded cathodes and gradually collects in a pool on the surface of the chloride. Looking into the cell, one sees the bright red surface of the molten chloride swirling violently under the pull of the magnetic field. Swept here and there on this surface are numerous shiny globules of metallic magnesium, drops which eventually coalesce to form a pool of the metal several inches deep. When this condition has been reached, two men dip out the molten metal into a gas-heated ladle for transfer to the first casting operation. Thereupon more chloride is poured into the cell and the cycle is repeated. Magnesium is removed from each cell about once a day.

The impure magnesium taken from the electrolytic cells is carried in the truck-mounted ladle to a row of moulds at one side of the cell room. In these moulds the magnesium is cast into short cylindrical pigs, each one weighing about 60 lb. The pigs are removed as needed to the refining plants. The electrolytic procedure is simplified to the extent that the chlorinators produce absolutely anhydrous $MgCl_2$. Efficiency of the B.M.I. electrolysis is well over 85 per cent., which was the highest mark attained previously.

To supply the 20,000 amp. current required, both motor-generator sets and mercury-arc rectifier equipment are used, with rectifiers supplying 60 per cent. of the power. Total power used is 220,000 kW., enough for a city the size of Los Angeles. In the actual electrolysis, about 8 kWh. are used per lb. of magnesium produced. Power enters the plant at 232,000 volts, is transformed down to 13,800 volts, and the portion used for electrolysis is converted to d.c.

Refining Units

B.M.I. now has a fine new refining plant and others are being built, but in the early days of the operation magnesium was refined "by hand," so to speak, because demand for the metal was so urgent. One of the original refining plants is still operating in order to keep the flow of magnesium ingots at its maximum, pending construction of a new refining unit. The new refining unit is housed in a separate building, and in this one unit nearly all the current output of metal can be refined. Along one side of the central room of the refining plant is a raised platform built around eleven pot furnaces, heated by oil, each holding two

tons of molten metal. The raw magnesium pigs from the cell houses are melted and purified in these pots.

When the sludge has settled to the bottom, the pot itself is lifted bodily out of the furnace by an overhead crane and is transferred to one of three casting machines on the opposite side of the room. These machines consist of an automatically controlled tilting frame to hold the pot, and an endless chain of 5-lb. moulds to receive the molten metal. The frame is, in fact, a tilting furnace, for it is heated by propane to keep the metal at the proper temperature during the pouring. The tilting is synchronised with the movement of the mould chain, so that each mould is filled with exactly the right amount of metal. One side of each mould is built up in a V shape which overlaps the low side of the neighbouring mould, so that no metal is spilled as the chain advances. Movement of both furnace and chain is consistently smooth, and the choking atmosphere of SO_2 which surrounds the hand operation is absent. A reducing atmosphere does surround the molten metal until it solidifies, but no fumes escape into the room.

Care is taken to prevent pouring out any of the sludge which has settled at the bottom, and when all possible pure metal has been poured out, the tilting furnace is returned to an upright position and the pot removed. The empty pot is transferred to the cleaning room and a fresh pot is immediately placed in the casting machine. In the cleaning room, the pots are emptied of sludge, and as much metal as possible is recovered. After a rapid inspection and cleaning, the pots are swung out again and put back into the nearest empty furnace to be refilled.

New Control Orders

Animal Oils and Fats

THE Animal Oils and Fats (Provisional Control) Order, 1939, the Animal Oils and Fats (Saponification and Splitting) Order, 1941, the Technical Tallows and Greases (Home Melt) Maximum Prices Order, 1941, and the Dripping (Maximum Prices) Order, 1943, have been revoked, and the provisions of these Orders have been re-enacted and consolidated in a new Order—the Animal Oils and Fats (Control and Maximum Prices) Order, 1943 (S. R. & O. 1943, No. 1768), which came into force on January 16. The only changes of importance are: (a) quantities of not more than 2 cwt. of home melt tallows and greases are released from the maximum price control; (b) the percentage of free fatty acids allowable in dripping is reduced from 2 to 1.5; and (c) suet is removed from the schedule of specified oils and fats.

LETTER TO THE EDITOR

Muriate of Potash

SIR,—On page 40 of your issue of January 8, it is stated that "this country is receiving its supply of muriate of potash for agricultural purposes from America and Russia." The author was apparently unaware that the bulk of the muriate of potash imported to this country since the war comes from Palestine.—Yours faithfully,

PALESTINE POTASH, LTD.,
G. A. STOLAR,
Secretary.

January 12, 1944.

Gas Industry's Future

Local Government Proposals

AN interim report has been issued by the sub-committee of the Association of Municipal Corporations which was appointed to consider the report of the Post-War Planning Committee of the British Gas Federation. The present report claims that the B.G.F. report did not give sufficient consideration to the transfer of the gas industry to local government ownership, and expresses the view that the gas industry should be operated as a social service for the benfit of the community, rather than for commercial gain.

The sub-committee evidently views with some alarm the proposal that, where integration cannot be brought about by agreement, it will be forced upon the owners of undertakings through a decision of the proposed Integration Tribunal, ratified, where necessary, by Parliament. The fear is, from the Corporations' point of view, that as the policy of the large gas concerns may be the acquisition of undertakings at present owned by local authorities, the local authorities might be at a disadvantage if the British Gas Association were to be the body responsible for initiating integration. The suggestion is therefore made that, if integration is to take place in the gas industry, a review of the industry as a whole must be made by some independent body, and proposals arising from their findings should be presented to Parliament with a view to appropriate legislation.

The report has been presented to the Minister of Fuel, and a further report is being prepared on the question of public ownership for the gas industry.

The U.S. Department of Justice has filed a suit in the Federal Court, aimed at breaking up an alleged international cartel in quebracho. Three U.S. corporations, one Canadian, one Argentine, and one British—the Forestal Land, Timber and Railways, Ltd., of London—are involved.

FUEL ECONOMY IN THE CHEMICAL INDUSTRY

Fuel Efficiency Lectures

IV.—Grinding Plant

by J. C. FARRANT

As there are so many factors involved in the various processes of which grinding equipment forms a part, it is a matter for the plant manager to consider whether by reason of improvements it pays to grind fewer hours, thereby saving coal direct, or by increasing production by unit of power, thereby economising coal. An analysis of the cause of those effects which reduce efficiency is here submitted as a basis for promoting discussion, regardless of the type of machine used.

To counteract fluctuations in the physical or chemical characteristics of the material to be ground, the feed to the grinding unit must be controlled so that the rate of feed is proportional to the work to be done. This may be the responsibility of the charge hand, or automatic (mechanical or electrical) feeding may be used.

Variation in Size of Feed

An increase in the size of the feed above normal is one of the most common causes of wasted power. The harder and tougher the material to be ground, the greater the drop in grinding efficiency. If this condition is temporary, the controls above referred to are adequate, but if a large tonnage of coarser material has to be dealt with, the problem is managerial. A feed coarser than normal is usually attributable to the deformation of wearing parts or a change in the setting of the preliminary reduction machines. The power required to prepare feed to mills by suitably designed crushing equipment is only a fraction of that required by grinding mills when performing a duty for which they are not designed.

A controlled feed to the grinding section is usually obtained by closing the circuit of the crushing unit with screens, and is another method by which power has been saved. Alternatively, close attention to the gaps or setting is required, and adequate replacement of wearing parts is needed, to maintain an even feed. The elimination of "fines" by screening ahead of crushers has also saved power.

Moisture in Feed

The degree of surface moisture that can be satisfactorily dealt with in a mill depends on several factors: the type of mill, the nature of the raw material, and atmospheric conditions. If the finished material is free-running and shows no tendency to pack at any point, drying is unnecessary. In general, the cost of the coal used to dry is more than counterbalanced by the saving in power in the grinding section.

In the production of powders below the sieving range, it becomes even more important to maintain maximum fluidity of the material, although stickiness may be caused by factors other than moisture. The sticking of fine particles to bins, bunkers, chutes, and in grinding equipment is a common source of trouble and waste of power. The application of electric vibration, however, has contributed materially to the solution of this problem, and eliminates the cost of maintenance caused by hammering.

It frequently happens that an open-circuit plant is installed for a given duty which is satisfactorily performed. Subsequently, a finer grading is required, and to meet this condition without change would mean a reduction in output; but with the addition of fine-classifying equipment and operating in closed circuit with the existing mill, output has been increased and the finished product more closely controlled. The tailings or oversize are returned to the mill for further grinding. Conversely, the raw material may be delivered with a large quantity of material already fine enough for ultimate use; it merely retards output to feed such material to a mill, and in such cases separating equipment has been installed ahead of the mills, thereby saving power.

Grading Specifications

Grinding efficiency or cost of production has been seriously affected by the issue of haphazard specifications. On the other hand, a rigid synthetic specification composed of several fractions may be issued, based on laboratory experiments, which does not conform to any known curve. Technically speaking, any specification could be reproduced in practice, given sufficient equipment, but mechanical efficiency is a relative term which must be subordinated to cost of production. The necessity for close co-operation between the laboratory and the process side must be emphasised.

Batch methods of grinding have to a considerable extent been superseded by continuous grinding in closed circuit with classifiers, resulting in lower costs of production and a close control of the finished product, which is a function of the classifier. Continuous grinding cannot always be employed satisfactorily where small quantities

of a variety of materials are required to be ground in batches, where small-scale grinding and mixing of two or more different materials are required, and particularly in grinding and mixing minerals where volatile solvents are used, but a prepared and controlled feed to batch mills is always preferable, from an efficiency standpoint, to charging with a rough unclassified feed without sufficient previous crushing.

General Maintenance and Operation

It is impossible here to refer to the many details which cause waste of power. "Lubrication" is very important. Large sums are spent annually on research in order to develop lubricants with special properties. Advice on this subject is available to industry through the various groups handling lubricants. Automatic lubrication has replaced the oil-can or grease-gun with good results.

Operation brings in the personal factor, often the most important with regard to "saving coal," and in particular, the charge-hand or "mill man." A good mill man will get the utmost out of a poor plant and press for improvements. An indifferent mill man in charge of a highly efficient plant may be the cause of loss of output amounting to thousands of tons per annum or a few tons of a valuable product, which amounts to the same thing, and it may not be entirely his fault. The cost of reduction or grinding in many cases constitutes the largest single item of the total cost of production. Yet too often a charge-hand's duties are often rigidly circumscribed, so that in effect he is required only to see that the wheels keep turning, and is called on to report only if anything goes wrong, whereas the essence of a good mill man is intelligent anticipation in order to prevent trouble from arising. It is not sufficient for a mill man to be thoroughly *au fait* with mills under his charge. He must have a sound knowledge of the equipment that precedes grinding, and in extraction plants must be familiar with the process following, as each section is dependent on the other. It is not the machine so much as the variables previously referred to which may affect the coal consumed if appropriate action is not taken.

Discussion

Q. Following Mr. Farrant's remarks about the importance of intelligent operation of the machine by the man on the spot, could he tell what instructions should be given to the operator and how he is to know when things are going wrong?

A. This question of operating personnel is one of the most important factors in relation to the saving of fuel. Low cost of operation depends upon the type of man and the kind of training received by the man, or men, in actual charge of the processing machines; on the other hand, it is not conducive to high efficiency if the wrong type of man is chosen or the mill man's actions are restricted in order to keep the wheels turning, and he is allowed to report to higher authority only if anything goes wrong. In certain cases good efficiency has been maintained and often increased by the application of a bonus system based on monthly output to the required grading. More opportunities should be given to the mill men for an occasional visit to manufacturers' plants and to processing plants similar to those which they operate, in order to widen their knowledge of the factors involved and to stimulate interest.

Q. Do makers of grinding machines give enough attention to the design of feeding appliances? Disintegrators have been seen where a man just puts a bucketful of stuff down now and again, poking it into the machine.

A. Accurate control of feed to mills is essential. Automatic means of control are, in consequence, being more widely adopted.

Overload Factors

Q. How much overload should be allowed on machines?

A. With a motor-driven mill, there are two factors: the overload on the motor and the overload on the mill. Generally speaking, overloads on either are undesirable, and in the mill the product must suffer either in reduced capacity or in grading. With the motor, safety arrangements are applied so that the motor is automatically tripped out when any serious overload occurs; on the other hand, there are certain cases, where the load is even, in which motors have been run for long periods at 5 per cent. over their rated capacity.

Q. Mr. Farrant's paper seems to have been a most admirable example of the type of paper wanted at these meetings, and has brought out all the practical points that have been run up against in operation. One point on which Mr. Farrant did not touch in ball-milling is the grading of the balls due to wear and the renewal of the correct size. A case was mentioned of four rotary kilns fired with pulverised fuel. A more or less mechanical screening device was rigged up to sort out the right sizes, and by charging with the right amounts and recharging the mills the power consumption was kept down by 10 per cent. That probably varies very much from one class of material to another, but could facts along those lines be added?

The subject of irregularity of feeding is certainly of the greatest importance, and it really applies more to the small disintegrating type of mill than to the large air-swept or wet-grinding mill. But the point

which Mr. Farrant made about allowing the size of classification to get out of hand on the crushing end can also apply in a closed circulation mill, where, if the classifier goes wrong, or if the grading or grinding due, for example, to the size of the balls in the ball-mill is irregular, the result may be that far too much stuff is being turned round and round instead of being removed at the right size. That reinforces Mr. Farrant's remark on specifications. A number of discussions have been had on this subject, where cases have been quoted of specifications of an inordinately strict and stringent nature, very often laid down by people who did not know how to measure them, and the result has been absorption of power for no good purpose. On grinding is it not true that more economy could be made in the direction of fuel saving by overhauling specifications than by overhauling mill plant?

A. There is no doubt that the rationed ball-load gives the maximum efficiency. The only reason that more use is not made of rationed ball-loads is the time and expense necessary to stop the mill, take out the charge, regrade the balls and fill the mill again. Therefore, the application of rationed ball-loads depends upon local conditions and the particular problem. It is really a question of balancing the economic factor against mechanical efficiency.

Specifications

Regarding the question: "Are there not far too many over-stringent specifications for finished material which result in the absorption of power?", the answer is "Yes." It is of paramount importance to issue correct specifications because the power consumption and the total costs are directly affected. The method by which a product is measured should be agreed. Specifications built up from laboratory experiments are not necessarily correct for full-scale plant production. The necessity for clear specifications becomes even more important when dealing with sub-sieve sizes, as it is not only a question of the cost of reducing the particular material to the surface required, but other factors are involved, such as agglomeration of the super-fines which may affect subsequent extraction. From a grinding standpoint, there should always be an upper limit, such as not more than 5 per cent. larger than 10 microns and not less than 75 per cent. minus-5 microns. Such an example can be correlated to a surface factor with a reasonable tolerance, so that rapid checks can be taken during milling operations with instruments suitably designed for this purpose.

With regard to the question concerning classification efficiency in relation to circulating loads, it is true that a classifier improperly designed or operated will have a direct effect on the output of the milling system and the consequent increase in the circulating load being returned for regrinding. If too many fines are included in this circulating load, it requires modification to the setting and/or re-design of the classifier or its components, and it is by studying such results in the field that developments in design arise.

Q. Will Mr. Farrant give us some information on the effect on power of asking for the grinding to be too fine? It is very often found in practice that the reaction between two solids goes so fast that a somewhat larger size can be asked for. For example, the difference between 99 per cent. through the 100 and 99 per cent. through the 200 might not be vital for some processes.

A. The power absorbed in grinding certain materials from 99 per cent. minus-100 to 99 per cent. minus-200 is approximately double, but the power varies with the class of mineral to be reduced. A specific instance comes to mind as an illustration: Two mills of a similar type grinding the same coal—one, for steam-raising, requiring 90 per cent. through 100 B.S.S., and the other pulverising coal for metallurgical furnaces, where the requirements were 90 per cent. through 200. For the first the power absorbed was 14 kW, and for the second 25 kW per ton.

Q. I was particularly interested in the slide which Mr. Farrant showed giving a particular instance in which crushing was more economically done to the size of $\frac{1}{4}$ in., after which it was more efficient to go on to grinding. My own particular job is pigment manufacture, and we have to deal with a very wide range of material. Has that approximate size of $\frac{1}{4}$ in. to be varied within wide limits?

Crushing *versus* Grinding

A. The size at which it pays to crush a mineral prior to grinding depends upon the hardness and/or toughness of that mineral. It has already been shown that on hard tough minerals for large scale milling, $\frac{3}{8}$ in., or slightly below, indicates the present most economical size at which to crush. The combined crushing and grinding curve shown on the slide is based on hard abrasive minerals and, in general, the softer the mineral the coarser it can be fed to the grinding units. Some types of mill will take a coarser feed than others. As an example, it would not be desirable to pre-crush gypsum too fine, as there is a possibility of getting metal-to-metal contact between the rollers and the grinding elements. In such cases $\frac{1}{2}$ in. to 1 in. is the preferable size of feed. Conversely, there are materials, such as cast iron and certain abrasives above the

hardness scale of 8, which it pays to crush to ⅛ in. before final reduction for fine grinding.

Q. Would it be more economical to crush limestone (60 lb. lumps) prior to grinding, in three stages or in two?

A. This depends upon the silica content of the limestone. A reasonably pure natural limestone is not an abrasive. The first step would be by jaw or gyratory crusher and the second by high-speed swing-hammer type. In two stages, a product passing ⅜ in. would be obtained which would be a satisfactory feed to mills designed for the grinding of limestone; if, on the other hand, the limestone were of a hard dense variety containing silica, a third stage to ⅛ in. or ¼ in. might well improve the overall efficiency in reducing from run-of-mine to the finished product. Three-stage crushing is common practice for the reduction of hard abrasive minerals on large-scale plants from run-of-mine to a size suitable for the milling section. The present practice is to screen that material which is fine enough from each successive stage and transport these fines to the mill bins, thereby increasing the efficiency and throughput of the crushing section.

Optimum Speed

Q. Is there an optimum speed for the most efficient running of a ball mill, and does that speed vary with the amount of noise emitted?

A. There is an optimum speed. The noise emitted varies with the speed and the amount of material inside the mill. The optimum speed depends upon several factors and is usually from 65 to 85 per cent. of critical in a ball-mill.

Q. The lecturer mentioned that there was a combination curve for the best efficiency between crushing and grinding. Is there a similar curve between grinding in a ball-mill and the classifier, and is the relation between the power absorbed by the crusher and the classifier sufficient to give a similar efficiency of power?

A. It would be difficult to construct a similar curve of practical value between grinding and classifying, as two different factors are involved, whereas with crushing and grinding it is merely a question of establishing a point on the combined curve in reducing the mineral from one size to a smaller size. In a dry-grinding air-swept unit the power required by the fan as compared with that of the mill may be 20 per cent. to 100 per cent., which indicates the variables associated with this type of reduction. This ratio differs considerably with the type of mill used and whether the mill is operated with cold or hot air for drying purposes.

Selecting the Type of Mill

Q. Can it be stated what is the relative power required with a roller, a hammer-mill, and a ball-mill doing a similar type of operation?

A. The roller-mill absorbs the least power per ton. The ball-mill absorbs less power per ton on fine grinding than the hammer-mill, and the hammer-mill absorbs less power per ton for coarse grinding than the ball-mill. The selection of the type of machine, however, depends very largely on the physical characteristics of the material to be ground—quite apart from the question of power absorbed; other factors being maintenance, availability, floor space occupied, and capital cost.

Q. Has the lecturer any experience of possible electrostatic conditions affecting the classification of the material?

A. Yes, in certain cases where the mill has been earthed, the sticking caused by electrostatic conditions has been prevented. Sometimes, however, earthing the mill has had no effect on the sticking propensities of fine particles in the mill system.

Q. With a tube-mill grinding silica with pebbles, the size of the pebbles decreased in course of time, and the smaller sizes had to be rejected. The size of the pebbles influenced the characteristic of the final ground powder. Did this introduce another variable into the effectiveness of the microphone device?

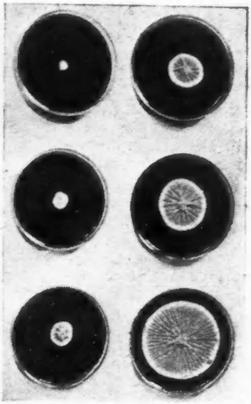
A. Yes, worn pebbles are of little use for grinding, and the note will undoubtedly change. The worn pebbles should be removed.

Q. If the note-range of the mill varies because the mill charge contains fragmentary pebbles, would it be possible to adjust the control of the microphone to the new note and thus maintain maximum efficiency under the changed conditions?

A. Yes.

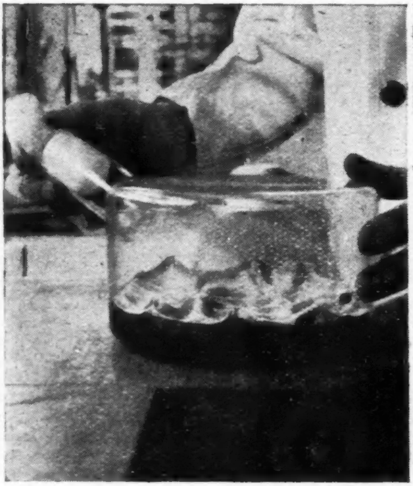
THE PRODUCTION OF PENICILLIN

LATEST details concerning the production and properties of pencillin were recounted, in our issue of January 8, in Mr. Colman Green's admirable review of last year's progress in drugs and fine chemicals. On the opposite page, some stages in the preparation of penicillin are illustrated, beginning with a portrait of its discoverer, Dr. Alexander Fleming.



1 (left). Professor Alexander Fleming, F.R.S., discoverer of penicillin, at work in his laboratory at St. Mary's Hospital, London.

2 (right). Specimens, prepared by Professor Fleming, of Penicillium growing in agar-agar culture dishes. From top left to bottom right is shown the growth at from one to ten days.



3 (left). The mould is set to grow in flasks 24 sq. in. in area, developing, as it grows, the appearance of a crinkled mat, known as a "felt," During the process of growth it exudes penicillin into the synthetic nutrient.

4 (right). A rack containing a single day's output from a factory where penicillin is prepared. In each of these 300 flasks a single dose of penicillin is being made. Three weeks or more is occupied in the preparation of the clinical material.

THE PRODUCTION OF PENICILLIN

The Education of Chemists

Report of the Advisory Board

PROPOSALS for the education of the chemist of the future have been published in a report of the Chemistry Education Advisory Board, issued by the Royal Institute of Chemistry. Professor Alexander Findlay, president of the Institute, is chairman of the Advisory Board.

Initially, the report considers the type of education for chemistry desirable in schools. It points out the danger of misdirecting pupils into the wrong type of school, not merely through a faulty assessment of the scholar's aptitude or ability, but also through insufficient appreciation of professional requirements and educational needs of the practising chemist.

For pupils leaving school at the minimum school-leaving age, whether 15 or 16, the report envisages a broad general and scientific education. The advisory board agrees with the Norwood Committee that a study of Natural Science should find a place in the education of *all* pupils up to the age of 15 (or 16); such a study should comprise a firm basis of factual knowledge, followed by training in scientific method and the inculcation of the spirit of science. It is pointed out, incidentally, that for the future welfare, not only of industrial science, but also of the nation in general, all those who may afterwards become leaders of the people, in whatever walk of life, should gain a fuller appreciation of scientific method and a greater understanding of the power of scientific knowledge.

A Wider Basis

Strong criticism is levelled at the too narrow and too intensive specialisation in science in post-school-certificate courses. Students of chemistry, as of other branches of science, should be afforded a wider basis of culture on which to build their intellectual life. The advisory board agrees with the Norwood Committee regarding the urgent need for remodelling scholarship examinations, the basis of which must be broadened. Something akin to the bursary system, already existing in the Scottish universities, could be advantageously extended to the universities of England and Wales. A corresponding modification of the scope of the Higher School Certificate examination is also recommended, and it is considered that exemption from the first year's course at a university, as the result of a pass in that examination, is undesirable. Three years at a university for an ordinary or pass degree, and at least four years for an honours degree in chemistry, are considered essential.

The above summarises the board's recommendations for the general training of a chemist. We append, in much greater detail, the sections of the report dealing with the education and training of industrial chemists above school-leaving age.

The board believes that it is of importance to emphasise that industry requires and can make use of, for administration, research, laboratory and process operations, etc., not only one type but many types of chemists, chemical assistants, and chemical technicians, whose education and training may vary greatly and proceed along diverse lines. Thus, those who are engaged in chemical industry and in other industries in which at least some background of chemical education is needed or desirable, may be divided broadly into groups.

Industrial Groups

PROFESSIONAL GRADES.

I. Directors of Chemical Works; Works or Departmental Managers; Directors of Research.
II. Research Chemists; Assistant Managers.
III. Assistant Research and Analytical Chemists.

NON-PROFESSIONAL GRADES.

IV. A. (i) Senior Chemical Assistants.
(ii) Junior Chemical Assistants (mainly engaged in junior analytical posts).
B. Chemical Technicians employed in a wide range of industries.
C. Chemical Works Operatives, *e.g.* process workers employed in actual chemical works.

Opportunity and suitable educational facilities should be provided to enable a worker beginning his career in any one of the lower grades to pass to a higher grade and to attain the highest qualification and professional position to which he may aspire and for which he shows himself fitted. It has, however, to be recognised as a fact that, within each group, there is a certain "intellectual ceiling" or level of capability above which many are unable to rise.

Part-Time Education

It must be accepted that many pupils who desire to adopt chemistry as a career will leave school at the minimum leaving age to take up work in chemical laboratories or in works. The board welcomes, therefore, the statement in the White Paper that it is the intention of the Government that there shall be compulsory part-time education up to the age of 18 at "young people's colleges." The nature of this education, whether general or vocational, or partly general and partly vocational, is of importance. Since in some, perhaps in many cases, employers may desire that their chemical assistants should, as soon as possible, engage in studies more directly connected with their daily work, it may happen that some of these will later find themselves debarred from professional advancement, owing to deficiencies in their

general or scientific education. To avoid this, the special requirements of young chemists should, at the minimum school-leaving age, be reviewed and care taken in assessing their abilities and in giving guidance with regard to their further education and training. Those who give such guidance should have a knowledge not only of the requirements of and the existing conditions in industry, but also of the regulations governing the entrance, as full-time students, into the universities or entrance on courses leading to an External Degree of the University of London. They should also be familiar with the requirements of the professionally qualifying body, the Royal Institute of Chemistry.

Advisory Committees

While the giving of vocational and educational guidance is part of the duty of the teacher or headmaster, it is recommended that, in the larger centres, advisory committees be set up consisting of representatives of schools, of universities and/or technical colleges, of chemists in industry, and of the Royal Institute of Chemistry. Such committees could give valuable assistance in assessing the aptitudes of, and in giving guidance regarding further education and training to pupils about to leave school and to enter industry. The advisory committees should also be available for assessing the qualifications and ability of part-time students above the minimum school-leaving age and for giving guidance regarding the nature of the educational course which they should follow. Power also might be given to the advisory committees to recommend suitable part-time students for the award of scholarships or bursaries to enable them to continue their education at a university or technical college. The advisory committees, further, would be in a position to offer valuable advice on the provision of part-time teachers, especially of technical subjects, and regarding the syllabuses of technical courses.

Besides those who are entirely or mainly engaged in carrying out chemical operations and who may properly aspire to some recognised status as chemists, there are, in many industries, young employees and skilled or semi-skilled craftsmen for the satisfactory carrying out of whose work a knowledge of chemistry and of chemical technique is essential, but for whom a higher standard of academic attainment in the science is neither called for nor expected. These groups of workers are distinct from those described above as chemical assistants. Only in exceptional cases will such workers aspire to any grade of professional status. For the part-time education of such workers various colleges throughout the country provide courses designed to prepare junior employees for work in connection with particular industries. A number of firms, also, have drawn up schemes of instruction which they regard as especially suitable for their own particular industry, and "works schools" have in some cases been established in which this special instruction is given. For entry on such courses, whether given in "works schools," or in technical institutions, school-certificate standard of general education is rarely required. Although, in the first, and often in the second year, of these part-time courses, chemistry, physics, and mathematics are taught, instruction in the later years is mainly confined to technological subjects bearing directly on particular industries.

Courses for Technicians

For the groups of workers under consideration, such courses of instruction may be of great value. For such workers good opportunities exist to rise to positions as foremen and departmental supervisors of process work; and if they later develop administrative ability they may reach more responsible positions as works managers. While the nature and extent of chemical or other scientific knowledge which should be possessed by technicians and operatives varies considerably in different industries, it is of great importance for the future prosperity of our industries that the standard of education, general, scientific, and technical, of all workers in industry should be raised, and this, indeed, is one of the main reasons for raising the minimum school-leaving age and for the introduction of compulsory part-time education up to the age of 18. It is therefore urged very strongly that, whether the part-time courses are given in "works schools," approved for this purpose by the Board of Education, or are given in central technical institutions, those who attend these courses, and especially those who, in the words of the White Paper, are "anxious to equip themselves more fully to advance in life" and who may aspire to rise to posts of managerial responsibility, should be encouraged to work for such nationally recognised certificates as the National Certificates in Chemistry and/or the Certificates of the City and Guilds of London Institute. Clearly, the courses of instruction provided must be such as will enable them to do so.

Chemical Assistants

Besides the group of chemical technicians and operatives, there is another important group of junior workers who may be referred to as chemical assistants. These are engaged in carrying out chemical operations of an essential even if often of a routine character. Many of these junior workers desire to adopt a chemical career and naturally aspire to attaining some recognised grade of chemist. The abler ones will look forward to reaching professional status. For such workers a higher standard of general and scientific knowledge is required than for those who have been classed as technicians and operatives, and facilities must be offered to them to fit them for promotion to higher posts on the chemical side of industry and to attain professional status. For such workers the more purely technological courses, designed for chemical technicians and operatives in various

industries, are not adequate. In not a few cases in the past, younger workers in chemical and allied industries, who had been directed into such courses, have later, to their great disappointment, found themselves debarred from advancement towards professional status owing to deficiencies in their general or scientific education.

Recommended Courses

The advisory board is strongly of opinion that pupils who leave school at the minimum leaving age and enter industry or chemical laboratories as chemical assistants, should, during the years of compulsory part-time education, seize the opportunity of laying a firm foundation of chemistry and physics, the sciences on which their industry is based and without knowledge of which they cannot qualify for advancement to more senior chemical posts. It is recommended, therefore, that they should pursue courses of study leading to National Certificates in Chemistry or, if the standard of matriculation has been reached, to the Intermediate Science examination of London University. Encouragement to pursue such study would, we believe, be given if the National Certificate were recognised as a qualification for advancement to more senior chemical posts and were made a definite step towards obtaining professional status through the examinations of the Royal Institute of Chemistry. We are of opinion that the courses for the Ordinary National Certificate should be purely scientific and not technological, and we are convinced that such training in science would be in the best interests both of industry and of the chemical assistants.

Higher Training

After passing the examination for the Ordinary National Certificate, chemical assistants would naturally pass on to the more advanced part-time courses leading to the Higher National Certificate; and in order that due account shall be taken of different aptitudes and aspirations, it is suggested that there should be two Higher National Certificates, one in pure chemistry and one in technological chemistry. The course for the Higher National Certificate in pure chemistry would cover more advanced work in inorganic, organic, and physical chemistry, and the award of this certificate would, along with the further necessary training, qualify for admission to the examination for the Associateship of the Royal Institute, provided the candidate had attained the necessary standard of preliminary education. By encouraging chemical assistants to study for National Certificates, industry would gain more intelligent and more highly qualified workers, and the workers themselves, having laid a broader basis of fundamental scientific knowledge, would be able to apply that knowledge to the understanding of the technical processes of different industries and so fit themselves for a wider range of activities and for posts in different industries.

The Professional Grades

The term "professional" is employed here to connote a qualification in general education and chemical knowledge and training represented by the Associateship of the Royal Institute of Chemistry, or by a good honours degree of a university. In general, those who aspire to, and have the ability to attain the professional grade, would proceed to a university or higher technical college to read for an honours degree. As in the case of honours courses in the universities, the first three years of study in the Higher Technical Colleges should be devoted mainly to pure science subjects, and only in the fourth year should any large part of the student's time be devoted to technological subjects. During his undergraduate years, a student of chemistry should be encouraged to visit as many industrial works as possible, in order that he may get some insight into the large-scale applications of chemistry and the conversion of a laboratory process. It is desirable that the student should spend part of his long vacations in works, so as to gain some experience of works practice and such courses, made available by certain firms before the war, have been found to enable the undergraduate to gain some practical experience and to decide whether the industrial life really appealed to him. They also gave an opportunity to the employer of selecting suitable men for posts at the end of their course of training. Facilities for attending such vacation courses should be greatly extended.

At the end of his honours course, the young graduate may at once seek for employment in a works, especially if his interests and abilities fit him for the production side of industry; but if he has the desire to obtain a post as a research worker, and shows the qualities necessary for success in research, it will be advisable for him to spend one or more years in receiving training in research either in a university or higher technical college.

Post-Graduate Study

If national standards in industry are to be improved, the need to harness scientific knowledge to the promotion of greater and more varied industrial productivity is imperative, and we would emphasise the importance of the fuller development of graduate schools of technological study on lines such as those followed at the Massachusetts Institute of Technology. The establishment of such schools of post-graduate study, either as separate institutions or in association with one or more of the technical colleges already in existence, adequately staffed and equipped with research programmes wisely co-ordinated, could do much to influence and improve the future of industry. By surveying and indicating new uses for our natural resources, material help also could be given towards a solution of the problem of unemployment.

In concluding this section of their report, the

advisory board brings to the attention of those engaged in directing industry how greatly they can help in putting into force the varions recommendations which have been made in the preceding pages.

How Industry Can Help

Thus, industry can give valuable help by:

(*a*) actively participating in the work of the advisory committees;

(*b*) impressing on their chemical assistants the desirability of pursuing systematic courses of study and encouraging them to do so by improved status and increased remuneration on the successful completion of such courses;

(*c*) co-operating with the authorities of Technical Colleges in selecting chemical assistants;

(*d*) providing financial help to deserving assistants to enable them to proceed to full-time day classes in order to complete their studies for professional recognition;

(*e*) providing vacation courses for undergraduates;

(*f*) providing Industrial Fellowships of post-graduate study and research;

(*g*) arranging interchange between members of industrial and technical-college staffs.

In its concluding paragraphs, the report deals briefly with the supply and training of teachers. The question in general is being investigated by the McNair Committee, set up by the Board of Education, and only a few remarks, especially applying to teachers of chemistry, are made.

Supply of Teachers

In view of the fact that the remuneration and prospects of a good chemist are usually greater in industry than in the teaching profession, it is not easy for technical colleges to obtain full-time teachers who have had some industrial experience, as would be desirable. Apart from a few who feel a definite vocation for teaching, many of the teachers are those who, after a not too successful period in industry, have returned to teaching in times of industrial depression. The remuneration of part-time teachers is also extremely low, and such work attracts only those chemists, engaged in works in the neighbourhood, whose industrial salaries are also low, although occasionally men in good positions engage in teaching from a sense of public duty. The advisory board would welcome any contribution that industry could make towards bringing teachers more closely into touch with industry.

It is finally recommended that the Chemical Education Advisory Board be kept in being as a central advisory body to be consulted by industrialists, examining bodies, and education authorities. It would gladly offer its assistance, also, in connection with the further training of men demobilised from the national services.

Personal Notes

SIR GEORGE NELSON, chairman and managing director of the English Electric Co., Ltd., has been nominated president of the Federation of British Industries, for a second year of office.

SIR DAVID MILNE-WATSON has resigned from the position of chairman of the Council of the British Gas Federation—a position which he has held since its foundation nine years ago—and has been succeeded by DR. E. V. EVANS, O.B.E.

SIR CLIVE BAILLIEU, deputy-president of the Federation of British Industries, has accepted the chairmanship of the F.B.I. Empire Committee. SIR PETER BENNETT, M.P., a past-president, will assist him as deputy-chairman of the committee.

MR. E. HUGH ARMITAGE has been elected to the board of the Power-Gas Corporation, Ltd., in place of his father, MR. ROBERT ARMITAGE, who has retired after serving as a director since the formation of the company.

MR. CHARLES DUNBAR, vice-chairman and managing director of the British Oxygen Co., Ltd., was entertained to dinner by his fellow-directors on Wednesday last week on the completion of fifty years' service in the industry. Lt.-Col. S. J. L. Hardie, the chairman, presented him with a canteen of silver and other gifts, on behalf of the company.

The Therapeutic Research Corporation has elected the following officers for the year 1944: chairman of board of directors, MR. H. JEPHCOTT (Glaxo Laboratories, Ltd.); deputy chairman, DR. F. H. CARR (The British Drug Houses, Ltd.); chairman, research panel, DR. A. J. EWINS (May & Baker, Ltd.); deputy-chairman, research panel, MR. F. A. ROBINSON (Glaxo Laboratories, Ltd.). DR. FRANK HARTLEY, Ph.D., B.Sc., Ph.C., F.I.C., has been appointed secretary and will take up duties early in 1944. The new offices of the Corporation are at General Buildings, 99 Aldwych, London, W.C.2. (CHAncery 8421.)

Obituary

DR. ANTHONY CHARLES SHEARMAN, Ph.D., who died in London on January 10, aged 23, as a result of injuries received, while engaged on Home Guard duties, from the premature explosion of an anti-tank grenade, was a brilliant young research worker who had specially interested himself in the chemistry of explosives.

DR. BIRKETT WYLAM, M.Sc., Ph.D., F.I.C., F.C.S., M.I.Chem.E., who died in Edinburgh on January 15, was Chief Inspector in the Department of Health for Scotland under the Alkali, etc., Works

Regulation Acts, and Inspector under the Rivers Pollution Prevention Act. He had held the combined post for 13 years. A graduate of the University of Durham, where he took his doctorate in 1925, he began his career in industrial chemistry with Morton Sundour Fabrics, Ltd., and later was research chemist and process manager with Scottish Dyes, Ltd. (I.C.I.), Grangemouth. He became an Associate of the Royal Institute of Chemistry in 1924, and served on the Council after being elected to Fellowship. He was a prominent member of the Edinburgh sections both of the Institute and of the Society of Chemical Industry.

General News——From Week to Week

Six youths, all under the age of 20, have been remitted for trial at the Sheriff Court in connection with the grenade explosion which wrecked the board room of I.C.I., Ltd., Blythswood Square, Glasgow.

The voluntary liquidation of the company known as I.C.I. (Dyestuffs), Ltd., having taken place, the concern is now known as Imperial Chemical Industries, Ltd., Dyestuffs Division.

At an extraordinary general meeting of the Eastern Chemical Co., Ltd., held last Monday, the sale of the company's fixed assets and goodwill in India, and of stocks, as referred to in our last week's issue (p. 87) was unanimously approved.

The rose-hip crop gathered in England and Wales last year was the largest on record, over 500 tons having been collected from the hedgerows. The vitamin-C content of this quantity is estimated as equivalent to that of 25,000,000 oranges.

An I.C.I. staff club has contributed five guineas to the Red Cross Penny-a-Week Fund for each of eight members recently returned from captivity in Germany, "because those concerned have stressed so much the value of Red Cross parcels during their imprisonment."

The Copper Development Association has issued a 44-page booklet entitled "Copper Alloy Resistance Materials," which gives details of all classes of copper alloys containing more than 25 per cent. of copper that are useful for resistances operating at temperatures up to 350° C. Alloys used for heating elements are not discussed. Interested persons can obtain copies free from the Association, at 9 Bilton Road, Rugby.

The F.B.I. Report on Industry and Research includes a recommendation suggesting the establishment of an organisation for continuously stressing the need for industrial research and for promoting it in all possible ways. The form and functions of such an organisation were discussed at a recent F.B.I. conference which was attended by representatives of the Royal Society, the D.S.I.R., Universities, and Research Associations. A sub-committee was appointed to inquire further into the subject and to report back.

The hint that the Ministry of War Transport may apply for compulsory orders if road transport operators do not voluntarily accept the Government's scheme for producer-gas vehicles was given by the Ministry's director of vehicle equipment, Mr. F. G. Smith, when he addressed a meeting in Scotland last week.

Among the firms manufacturing penicillin is Kemball Bishop & Co., Ltd. This fact is revealed in the report on the use of the drug in the treatment of battle wounds in the Middle East which Professor H. W. Florey and Brigadier Hugh Cairns recently submitted to the War Office. An interesting summary of this report appears in the *Pharmaceutical Journal* of January 15.

The National Book Council (3 Henrietta Street, London, W.C.2) has published an interesting Book List (No. 198) on *Pure Science*, covering Biology, Chemistry, Mathematics, and Physics. The great majority of the books included in the lists were published in England within the last ten years; even so, some of them are already out of print.

An accident on January 13 at the Forth Chemical Works, Bo'ness, belonging to Thomas Ovens and Sons, Ltd., caused injury to several people. A large part of the top floor of a three-storied building collapsed, and the debris fell on the company's office near by, where members of the staff were trapped and could not be released until the N.F.S. arrived.

A research association is being formed by the British shipbuilding industry for the development of all branches of research connected with shipbuilding, marine engineering, and ship-repairing. The step has been taken after consultation with appropriate Government departments, and the D.S.I.R. will be represented on the Council. A research board will also be constituted, covering a wide representation of technical and other interests involved in the activities concerned.

Foreign News

The two fluorspar mines at St. Lawrence, Newfoundland, are operating on a full-time basis, and one of the mines is reported to have an increased production capacity.

Reports of a series of strikes and acts of sabotage at the steelworks of Vitkovice, Czechoslovakia, have reached Zurich. It is stated that the Germans shot many workers and suppressed all news of the incident.

The Japanese firm, Chemical Industrial Co., has organised a subsidiary in Kwantung, with 15 million yen capital. Magnesium will be one of the new concern's principal products.

The fertiliser plant of Canadian Industries, Ltd., at Belœil, Quebec, is being extended at a cost of about £80,000. Additional equipment will be provided for the production of 60 per cent. more superphosphate.

Sabotage activities carried out by patriots in France during August last included the destruction of 300 tons of duralumin at the Rive-de-Gier works, between Lyons and St. Etienne.

The interchange of technical information between Russia and Czechoslovakia was one of the subjects discussed between the two countries recently. The pact which was signed is reported to include an agreement on technical matters.

The B.F. Goodrich factory at Port Neches, Texas, now in full operation, is reported to be the largest synthetic rubber plant in the world. Its capacity is 120,000 tons of synthetic rubber a year. Butadiene comes from a petroleum refinery near by, and styrene from a neighbouring chemical plant.

It is understood in Washington that the U.S. Department of Justice may delay the anti-trust suit against the Du Pont company and I.C.I. until after the war, states Reuter. This is at the request of the War Department which believes that litigation at this moment would interfere with production.

The insecticidal properties of inert dusts are being investigated in Australia by the Council for Scientific and Industrial Research. Large-scale trials followed laboratory tests, and it has been found that a very real degree of protection from attacks by the two grain-weevils is given by magnesite powder, at a concentration as low as 4 oz. per bushel of wheat over a period of twelve months. Dolomite and a diatomaceous earth also seem to be effective.

Finnish-German negotiations for the exploitation of nickel mines in the Petsamo area have been concluded at Helsinki, said a Soviet News Agency message from Stockholm last week. Since the beginning of the war these deposits have been worked by the Germans on the strength of a provisional agreement, the message said, adding that the recent negotiations had evidently ended in Finnish agreement with a German proposal that exploitation of the nickel deposits should be turned over to German companies for 20 years.

United States copper production in 1943 totalled 1,194,565 tons, compared with 1,152,344 in 1942. Of this amount 1,054,855 (1,050,469) tons were of primary production, while refined production aggregated 1,206,871 tons (1,135,708). Consumption during 1943 totalled 1,643,955, an increase of 8719 tons, according to the Copper Institute, reported by Reuter.

Eight new wood-distillation plants in various parts of the country are among new chemical enterprises recently sanctioned in Spain, according to the Spanish journal *Ion*. Also authorised are a cryolite works (Fluoruros S.A., Oviedo), a potassium permanganate factory (J. B. Méndez, Albacete), and a carbon tetrachloride plant (Soc. Electroquímica de Flix, Tarragona).

The Government of India has issued a notification prohibiting future trading in ground-nut oil, linseed oil, mustard oil, rapeseed oil, castor oil, sesamum oil, and coconut oil, and corresponding varieties of oilcake, from January 12, reports Reuter from New Delhi. Forward contracts of a specific nature, or against which contracts are not transferable to third parties, are exempted from the prohibition.

The South African Torbanite Mining and Refinery Company is negotiating with the Union Government for an extension of its present concessions with a view to doubling its oil-extraction plant at Ermelo, so as to dispense with the use of imported petrol. If these concessions are granted, the company intends to increase its capital by £350,000, and to apply to the British Treasury for permission to issue the new shares to British shareholders.

The Turkish Government, in deference to Allied advice, has ordered that no pharmaceutical products be sold in Turkey except by order of a physician known to the pharmacist personally. This is to prevent German agents from buying up products not available in Germany since the I.G. and other big pharmaceutical factories were destroyed by the R.A.F. It had been found that 60 per cent. of pharmaceutical supplies in Turkey were being bought up by the Germans.

A group of American experts on commodity control and economics have suggested to the U.S. Government that a national reserve of strategic raw materials should be accumulated in the five or six years following the close of the war. They consider this would act as a protection against any future national emergency. The proposed stockpile would include £3,000,000 worth of chemicals and drugs, £75,000,000 worth of petroleum and petroleum products, £12,500,000 worth of manganese, £6,500,000 worth of chrome, and non-ferrous metals to the value of £12,500,000.

Forthcoming Events

The sixth set of lectures on fuel economy arranged jointly by the **Association of British Chemical Manufacturers** and the **British Chemical Plant Manufacturers' Association** will be given on **January 26** at 3.30 p.m. in Reynolds Hall, College of Technology, Manchester. Mr. L. S. Yoxall, of Foxboro-Yoxall, Ltd., will present a paper on "Automatic Heat Control" and Mr. J. W. Grose, of Kestner Evaporator & Engineering Co. Ltd., will talk on "Evaporators." As before, the introductions will be brief, and discussion on personal practical experiences will follow. Hon. members should notify Mr. W. Murray, Liverpool Borax Co., Ltd., 6 St. Paul's Square, Liverpool, of their intention to attend. The lectures will be repeated in London on **February 9.**

A meeting of the **Institute of Fuel** will be held in the lecture theatre of the Institution of Electrical Engineers, Savoy Place, London, W.C.2, on **February 1,** at 2.30 p.m., when a paper on "Liquid Fuels and Organic Chemicals from Coal and Home-Refined Petroleum" will be given by Mr. Harold Moore, M.Sc., F.Inst.Pet.

Mr. E. C. Goldsworthy, Development Officer of High Duty Alloys, Ltd., will lecture the **Royal Society of Arts** on "Light Alloys in Post-War Britain" on **February 2.** The meeting will take place at the Society's premises in the Adelphi, London, W.C.2, at 1.45 p.m.

Company News

Unchanged interim dividends are being paid by **A. Boake Roberts & Co., Ltd.** (1½ per cent., tax free), and **W. J. Bush & Co., Ltd.** (4 per cent.).

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for errors that may occur.

Mortgages and Charges

(Note.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described therein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every company shall, in making its Annual Summary, specify the total amount of debt due from the company in respect of all Mortgages or Charges. The following Mortgages and Charges have been so registered. In each case the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary, but such total may have been reduced.)

EUCOS PRODUCTS, LTD., London, N.W., chemists. (M., 22/1/44.) December 20, charge, to Barclays Bank, Ltd., securing all moneys due or to become due to the Bank; charged on All Saints, St. Aldhelm's Institute, Branksome. *Nil. July 15, 1943.

Companies Winding-up Voluntarily

I.C.I. (FERTILIZER & SYNTHETIC PRODUCTS), LTD. (C.W.U.V., 22/1/44.) December 31 (members). J. D. Smith of I.C.I. (Fertilizer & Synthetic Products), Ltd., Billingham, Co. Durham, appointed liquidator.

I.C.I. (LIME), LTD. (C.W.U.V., 22/1/44. December 31 (members). J. R. Murray of I.C.I. (Lime), Ltd., Royal Exchange, Buxton, appointed liquidator.

I.C.I. (PAINTS), LTD. (C.W.U.V., 22/1/44.) December 31 (members). H. W. Phillips of I.C.I. (Paints), Ltd., Wexham Road, Slough, appointed liquidator.

New Companies Registered

North British Plastics, Ltd. (384,531).—Private company. Capital: £100 in £1 shares. Manufacturers of and dealers in synthetic resins, plastic powders and compounds, chemical and industrial preparations, etc. Directors: J. F. Chapman; J. S. Tempest. Registered office: 3 Scarborough Street, West Hartlepool.

Chemical and Allied Stocks and Shares

THERE was again only moderate business in Stock Exchange markets, where sentiment reflected the widespread tendency to await "second front" developments. Confidence was indicated by the little selling in evidence, while the continued firmness of British Funds and other high-class investment stocks was a helpful influence. Movements in industrial shares were mostly small, and, in numerous directions, any decline in prices subsequently attracted buyers.

In accordance with the general tendency, movements in shares of companies connected with the chemical and kindred industries did not exceed more than a few pence as compared with a week ago. Imperial Chemical strengthened to 38s. 3d. following an earlier small decline, and were slightly better on balance. Business around 76s. has been recorded in B. Laporte, while elsewhere Lewis Berger continued to improve and, at the time of writing, have changed hands up to 95s. 6d. Burt Boulton were dealt in at 22s. 6d., and B.D.H. ordinary were 23s. Moreover, Goodlass Wall 10s. ordinary maintained their recent improvement to 17s. There was again rather more attention given to Gas Light & Coke ordinary, which further improved to 20s. 6d. on market hopes that the forthcoming announcement may show a total dividend of 3½ per cent. for the past year. Elsewhere, British Thermostat 5s. ordinary shares changed hands at 19s. 6d. Cellon 5s. ordinary rose to 24s., while Greeff-Chemicals 5s. ordinary marked 7s. 3d., and William Blythe

3s. shares transferred at 8s. 9d. at one time. W. J. Bush ordinary were again quoted at 60s. and remained firmly held; business at £5½ was recorded in the 5 per cent. £5 preference shares.

In other directions, Borax Consolidated eased, following their recent rise, and were 37s. 6d., compared with 38s. a week ago. British Aluminium at 47s. 6d. were unchanged on balance, while Turner & Newall at 78s. were within 9d. of the level of last week. British Oxygen eased from 81s. 3d. to 80s. 6d., but elsewhere British Match had strengthened to 40s. at the time of writing. A slightly higher level of 13s. 6d. was made by Imperial Smelting. General Refractories were well maintained at 17s. 1½d.; the yield on the last-named is moderate, but this is a case where there is talk in the market of a moderately higher dividend. Nairn & Greenwich, which remained under the influence of the results and annual meeting, were firm at 71s. 3d., compared with 68s. 9d. a week ago. Barry & Staines were slightly higher on balance at 45s. Following an earlier small decline, Triplex Glass rallied to 38s. 9d. Moreover, at the time of writing, Lever & Unilever have been well maintained at 36s.; based on the 5 per cent. dividend which has ruled in recent years, the yield is small, but the prevailing assumption is that after the war the dividend level may be restored to 10 per cent. An improvement from 31s. 6d. to 32s. was recorded in United Molasses. The units of the Distillers Co. eased from 88s. 6d. to 88s. Dunlop Rubber were little changed at 40s. 6d., at which the yield is slightly below 4 per cent. on the 8 per cent. dividend paid for 1942. Business around 47s. was recorded in Fisons ordinary shares. Among plastics, De La Rue ordinary moved back to 158s. 9d. Erinoid 10s. ordinary were again 10s. 6d., and British Industrial Plastics 2s. shares transferred around 6s. 10½d.

Among other shares, Associated Cement strengthened to 64s. 6d., compared with 63s. 6d. a week ago. British Plaster Board at 29s. were also higher on balance. Although best prices touched in the past few days were not fully held, there were on balance a number of gains in the iron, steel and allied sections. Tube Investments were 94s., compared with 93s. 9d., and Stewarts & Lloyds 53s. 9d., as against 53s. 1½d. a week ago. Among textiles, British Celanese have reacted from 28s. 3d. to 27s. 3d. at the time of writing. Boots Drug moved slightly higher to 42s., and Sangers were 23s. 4½d.

British Chemical Prices

Market Reports

STEADY conditions have prevailed in the London chemical market during the past week, and a moderate weight of new inquiry has been in circulation. The movement to the main consuming industries, as represented by contract deliveries, is reported to be satisfactory. In most directions the price position is unchanged with a firm undertone. Acetic, oxalic, tartaric and citric acids are strong, with offers finding a ready outlet, and much the same can be said for the potash and soda products. In other sections of the market there is little fresh interest to report. Among the coal-tar products, pitch continues firm, and most other items are sold well ahead.

MANCHESTER.—Prices maintain a strong front almost throughout the Manchester chemical market. In a good many lines contract bookings are fairly extensive and deliveries against these are on a steady scale, while a moderate weight of new business has been transacted during the past week. Bleaching, dyeing, and finishing chemicals are all in fair request and users outside the textile trades are maintaining a generally steady demand. Among by-products toluol and benzol are active sections and a fair trade is being done in xylols, while the demand for creosote oils remains very brisk.

GLASGOW.—In the Scottish heavy chemical trade there has been a marked improvement for home business during the past week. Export business remains rather restricted. Prices keep very firm.

Talc Prices

Selling prices of the various grades of talc have now been fixed by the Ministry of Supply as follows (per ton for 1-ton lots and over). CANADIAN POWDER: Grade T.50, RS/3, £15 15s.; Snowhite, £20 10s.; BR, £19; AI, £19 10s.; AA, £16; 693, £19; RVI, £20; BMI, £15 10s. EGYPTIAN POWDER: £31. SOUTH AFRICAN POWDER: £19. INDIAN POWDER: Grade X.X., X.X.X., and C.200, £21 10s.; crude, £21 7s. 6d. NEWFOUNDLAND PYROPHYLLITE: £17 5s. EIRE: Off-colour, £21 10s. £2 15s. to £4 extra per ton for lots between 5 cwt. and 1 ton.

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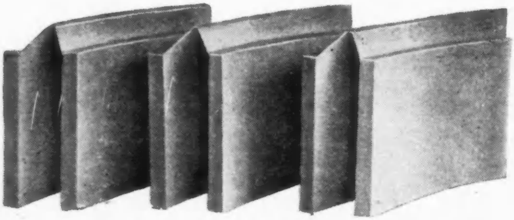

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